6 EXPLOSIVES

6.1 Introduction to Explosives

6.1.1 Objectives

Through completion of this module the trainee will develop the theoretical knowledge to be conversant in:

- The history and development of explosives;
- The terminology and vocabulary of explosives;
- The manufacturing process of explosives;
- Safety considerations in manufacturing and handling explosives;
- Compositions of explosives to include chemical formulations and structures and manufacturing formulations;
- The relationship between chemical structure and properties of sensitivity, stability, etc.;
- The basic construction of commercial devices;
- The basic construction of improvised devices;
- The use of household products in improvised devices;
- Physical evidence encountered in submissions and the potential value of that evidence (logos, endcaps, paper, writings, etc.); and,
- Fireworks, model rocket engines, and other pyrotechnics.

6.1.2 Required Readings

An enormous amount of background reading is required, the majority of which should be done prior to discussions with the trainer.

6.1.2.1 Davis, Tenny L., The Chemistry of Powder and Explosives, Angriff Press: Hollywood, CA, 1975, pp.1-122, 141, 195, 287-367.

6.1.2.2 Ellern, Herbert, Military and Civilian Pyrotechnics, ed. 2, Chemical Publishing Company: New York, New York, 1968, pp. 131-144.

6.1.2.3 Fordham, S., High Explosives and Propellants, 2nd ed., Pergamon Press: Oxford, England, 1980, pp. 1-28, 35-74, 93-131, 164-196.

6.1.2.4 Meidl, J. H., Explosive and Toxic Hazardous Materials, Glencoe Press: Beverly Hills, CA, 1970, pp. 31-74.

6.1.2.5 National Bomb Data Center, F.B.I., Introduction to Explosives, Picatinny Arsenal: Dover, NJ, 1973.

6.1.2.6 Saferstein, Richard, Criminalistics: An Introduction to Forensic Science, ed. 2, Prentice-Hall, Inc: Englewood Cliffs, NJ, 1981, pp. 253-279.

6.1.2.7 Scott, Lee, Pipe and Fire Bomb Designs, Paladin Press: Boulder, CO, 1994.

6.1.2.8 Stoffel, J., Explosives and Homemade Bombs, ed. 2, Charles C. Thomas Publishers: Springfield, Ill., 1972, pp. 35-108, p. 191-226.

6.1.2.9 Stromberg, Maehly, Chemical Criminalistics, O. Brandstetter: Wiesbaden, Germany, 1981, pp. 65-85.

6.1.2.10 U.S. Treasury, Firearms and Explosives Tracing Guidebook, revised May, 1990, Publication number ATFP7520.1 (11-88), pp. 51-107.

6.1.3 Questions

The trainee will provide written answers to the following questions:

- What is an explosion? What are the three types of explosions?
- What is an explosive?
- What is an explosive device?
- What is an IED?
- What is a low explosives?
- What is a high explosive?
- What is meant by detonation?
- What is a low order detonation?
- What is a high order detonation?
- What is meant by deflagration?
- What is the composition of singe/double/triple base smokeless powder?
- What is the composition of black powder?
- What is the composition of Pyrodex?
- What is the composition of Black Canyon Powder?
- What is the composition of Triple 7 powder?
- What are the three primary effects of an explosion?
- What is shrapnel?
- What is the difference between an explosive mixture and an explosive compound?
- How is a high explosive detonated?
- Give an example of a two-step low explosive train.
- What are primary explosives and how are they used? List examples.
- What is a secondary high explosive? List examples.
- Give an example of a three-step high explosive train.
- What are the ingredients in commercial dynamite?
- What is a binary explosive and how does it work?
- What is a chemical reaction bomb? Give examples of chemicals used.
- What is ANFO?

6.1.4 Practical Exercises

6.1.4.1 The trainee will burn samples of at least five black powder and/or black powder substitutes and record all observations. Samples will be retained for further analysis.

6.1.4.2 The trainee will burn samples of at least three smokeless powders and record all observations. Samples will be retained for further analysis.

6.1.4.3 The trainee will burn a small amount of pyrotechnic safety fuse and record all observations.

6.1.4.4 The trainee will observe the construction of devices under the supervision of qualified personnel if possible.

6.1.4.5 The trainee will recover device debris after initiation of devices by qualified personnel if possible. The trainee will observe and document all surviving device components and all unaccounted for device components.

6.1.4.6 The trainee will view items associated with high explosives, such as blasting caps, detonation cord, and boosters.

6.1.5 Evaluation

6.1.5.1 The trainer will review the written answers to the questions with the trainee.

6.1.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

6.1.5.3 The trainee will be quizzed orally upon the subject matter.

6.1.5.4 Review of practical exercises.

6.2 Recognition, Collection, Packaging and Controls

6.2.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Describe to an investigator the proper way to collect explosives evidence;
- Recommend proper packaging for explosives evidence; and
- Detail the proper controls that are to be taken and why.

6.2.2 Required Readings

6.2.2.1 Midkiff, Charles, R., "Arson and Explosive Investigation," Saferstein, Richard, Forensic Science Handbook Vol. 1, 2nd ed., Pearson Education Inc.:Upper Saddle River, NJ, 2002, pp. 498-524.

6.2.2.2 Trace Evidence Handbook, Internal Publication, pp. 3-8, 48-63.

6.2.2.3 Virginia Division of Forensic Science Evidence Handling Guide:
- Examples of Trace Evidence Submissions
- Trace Evidence Section

6.2.3 Questions

The trainee will provide written answers to the following questions:

- True of False: With new technology, two-way radio equipment may now be safely used near the site of a bomb scene.
- What is the "Golden Rule" of a bomb scene search?
- How should chemical reaction bombs be packaged?
- Will the laboratory analyze explosive devices which have not been rendered safe?
- Describe bomb scene investigation.
- Where at a bomb scene is it most likely to find unconsumed explosive material?
- What types of materials/debris should be collected from a bomb scene?

6.2.4 Evaluation

6.2.4.1 The trainer will review the written answers to the questions with the trainee.

6.2.4.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

6.2.4.3 The trainee will be quizzed orally upon the subject matter.

6.3 Stereomicroscopic Evaluation of Explosives

6.3.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Take appropriate notes;
- Use a stereomicroscope properly;
- Work with small samples;
- Recognize morphology of various explosive powders and residues; and
- Recognize and recover intact low explosive particles in debris.

6.3.2 Required Readings

6.3.2.1 De Forest, Peter R., "Foundations of Forensic Microscopy," Saferstein, Richard, Forensic Science Handbook Vol. 1, 2nd ed., Pearson Education Inc.:Upper Saddle River, NJ, 2000, pp. 231-232.

6.3.2.2 Saferstein, Richard, Criminalistics: An Introduction to Forensic Science, 2nd ed., Prentice-Hall, Inc, Englewood Cliffs, NJ, 1981, pp. 148-150.

6.3.3 Questions

The trainee will provide written answers to the following questions:

- The stereomicroscope is the least frequently used microscope in a typical crime laboratory. (True or False)
- The stereomicroscope offers a large _____ between the objective lens and the specimen.
- The stereomicroscope is actually two monocular _____ microscopes properly spaced and aligned to present a three-dimensional image of a specimen.

6.3.4 Practical Exercises

6.3.4.1 The trainer will discuss with the trainee how to take appropriate notes, how to properly use worksheets and what abbreviations are in standard use for explosives analysis.

6.3.4.2 The trainee will at a minimum view the following samples under the stereomicroscope, record their observations and prepare sketches as appropriate:

- Different grades of black powder
- Pyrodex and other black powder substitutes
- Smokeless powder (tube, perforated tube, disc, perforated disc, ball, flattened ball, lamels, etc.)
- Flash powder
- Pyrotechnic safety fuse

6.3.4.3 The trainer will provide a "debris" sample with intact low explosive particles present. The trainee will search the debris and isolate and report any intact particles found. The trainer may also include other materials, such as pyrotechnic safety fuse, which might typically be encountered in a debris sample and request that the trainee recover and list these as well.

6.3.4.4 The trainee will observe devices of known construction in post-blast condition.

6.3.4.5 The trainee will examine at least five secondary high explosives under the stereomicroscope and record observations.

6.3.5 Evaluation

6.3.5.1 The trainer will review the written answers to the questions with the trainee.

6.3.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

6.3.5.3 Review of practical exercises.

6.4 Extractions

6.4.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Follow the extraction scheme as outlined in the Trace Evidence procedures manual.

6.4.2 Required Readings

6.4.2.1 Parker, R.G., "Analysis of Explosives and Explosive Residues, Part 3: Monomethylamine Nitrate," *Journal of Forensic Sciences*, Vol. 20, No. 2, 1975, pp. 257-260.

6.4.2.2 Beveridge, A.D., Development in the Detection and Identification of Explosive Residues, Central Police University Press: Vancouver, BC, Canada, 1992, pp. 33-42.

6.4.3 Questions

The trainee will provide written answers to the following questions:

- Prepare a flow chart of the extraction scheme as outlined in the Trace Evidence procedures manual.
- What type of extraction would be performed on a suspected acid/aluminum reaction bomb?

6.4.4 Practical Exercises

6.4.4.1 Using the flow chart of the extraction scheme from 6.4.3, explain to the trainer the reasoning behind each step.

6.4.4.2 The trainee will follow the prescribed extraction scheme on at least one of the retained burned black powders and any burned black powder substitutes from Sections 6.1.4.1, as well as at least one of the retained burned smokeless powders from Section 6.1.4.2. (A methanol and ether extraction are not necessary.)

6.4.5 Evaluation

6.4.5.1 The trainer will review the written answers to the questions with the trainee.

6.4.5.2 The trainer and trainee will review and discuss the pertinent points of each of the required reading.

6.4.5.3 The trainee will be quizzed orally upon the subject matter.

6.4.5.4 Review of practical exercises.

6.5 Microchemical Testing

6.5.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Safely prepare microchemical reagents;
- Determine the microchemical properties of explosives and explosives residues; and
- Recognize the limitations and specificity of microchemical tests.

6.5.2 Required Readings

6.5.2.1 Anger, V., and Feigl, F., Spot Tests in Inorganic Analysis, ed. 6, Elsevier Publishing Company: Amsterdam, The Netherlands, 1972.

6.5.2.2 Bureau of Alcohol Tobacco and Firearms, Spot Tests- Systematic Analysis of Low Explosives, revised 6/1988.

6.5.2.3 Feigl, F., Spot Tests in Organic Analysis, ed. 7, Elsevier Publishing Company: Amsterdam, The Netherlands, 1966.

6.5.2.4 Jungreis, Ervin, Spot Tests Analysis, John Wiley and Sons, Inc.: New York, New York, 1985.

6.5.2.5 Parker, R.G., Stephenson, M.O., McOwen, J.M., Cherolis, J.A., "Analysis of Explosives and Explosive Residues. Part 1: Chemical Tests," *Journal of Forensic Sciences*, Vol. 20, 1975, pp. 133-140.

6.5.3 Questions

The trainee will provide written answers to the following questions:

- Why are microchemical tests referred to as "presumptive" tests?
- What does the DPA test check for?
- How do you know if your reagent is working properly?

6.5.4 Practical Exercises

6.5.4.1 The trainee will assemble the necessary solvents and acids and prepare the necessary reagents. The trainee will become familiar with the requirements and will perform appropriate QC checks.

6.5.4.2 The trainee will take known samples containing bromide, carbonate, chlorate, chloride, iodide, nitrate, nitrite, perchlorate, and sulfate, and react each with barium chloride, brucine, diphenylamine, silver nitrate, conc. sulfuric acid, and triphenylselenium chloride. Additionally, acetic acid should be added to any precipitate formed by reaction with barium chloride. Note whether the precipitate remains or dissolves. The trainee will make a table containing the results of each test and compare these results to literature.

6.5.4.3 The trainee will react 1-naphthol followed by conc. sulfuric acid with sugar and record results.

6.5.4.4 The trainee will react ammonium nitrate with Nessler's reagent and record results.

6.5.4.5 The trainee will test HTH pool chlorinator for the hypochlorite ion and record results.

6.5.4.6 The trainee will react TNT and DNT with brucine and record results.

6.5.4.7 The trainee will react a chlorate-containing sample with aqueous aniline sulfate followed by conc. sulfuric acid and record results.

6.5.4.8 The trainee will perform microchemical tests on black powder, black powder substitutes (including Pyrodex), smokeless powder, and flash powder, generating a low explosives microchemical test worksheet for each.

6.5.4.9 The trainee will perform microchemical tests as specified in the Trace Evidence procedures manual on the extracts obtained in 6.4.4.1. (Do not consume the entire extracts, as they will be needed for further analysis.)

6.5.4.10 The trainer will provide the trainee with at least ten unknown samples. The trainee will perform microchemical tests to determine what ions are present in the samples, generating a low explosives microchemical test worksheet for each sample. The samples may include mixtures.

6.4.5 Evaluation

6.5.5.1 The trainer will review the written answers to the questions with the trainee.

6.5.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

6.5.5.3 Review of practical exercises.

6.6 X-Ray Diffraction (XRD)

6.6.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Explain the basic theory of XRD and be able to explain the function of the major components of the instrument;
- Explain and be able to perform appropriate quality checks;
- Explain the strengths and limitations of this technique;
- Prepare samples for analysis using a variety of methods; and,
- Interpret the results obtained using library searches and/or comparison to known standards.

6.6.2 Required Readings

6.6.2.1 Midkiff, Charles, R., "Arson and Explosive Investigation," Saferstein, Richard, Forensic Science Handbook Vol. 1, 2nd ed., Pearson Education Inc.: Upper Saddle River, NJ, 2002, pp. 513-515.

6.6.2.2 Saferstein, Richard, Criminalistics: An Introduction to Forensic Science, 2nd ed., Prentice-Hall, Inc, Englewood Cliffs, NJ, 1981, pp. 136-137.

6.6.3 Questions

The trainee will provide written answers to the following questions:

- What kinds of explosive residues would be expected when analyzing deflagrated black powder?
- What are some organic compounds that might be analyzed via XRD?
- In general, in what percentage must a component of a mixture be present in order to be identified on XRD?

6.6.4 Practical Exercises

6.6.4.1 The trainee will complete the X-Ray Diffraction Section of the Trace Evidence training manual.

6.6.4.2 The trainee will analyze common explosive materials and combustion products using different sampling techniques available. Include as a minimum burned and unburned black powder, burned and unburned Pyrodex®, Triple7®, potassium nitrate, potassium sulfate, sulfur, potassium chloride, potassium perchlorate, and sucrose.

6.6.5 Evaluation

6.6.5.1 The trainer will review the written answers to the questions with the trainee.

6.6.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

6.6.5.3 Review of practical exercises.

6.7 Ion Chromatography (IC)

6.7.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Explain the basic theory of IC and be able to explain the function of the major components of the instrument;
- Explain and be able to perform appropriate quality checks;
- Explain the strengths and limitations of the technique and of the different detectors; and,
- Prepare samples for analysis and interpret the results obtained in comparison to known standards.

6.7.2 Required Readings

6.7.2.1 Beveridge, A.D., Development in the Detection and Identification of Explosive Residues, Central Police University Press: Vancouver, BC, Canada, 1992, p. 25.

6.7.2.2Grasselli, J., "Ion Chromatography in Bombing Investigations," *Analytical Chemistry*, American Chemical Society, 1983, pp. 1468A-1472A.

6.7.2.3 Green, M. "Ion Chromatographic Analysis of Perchlorate in Perchlorate/Sugar Explosive Devices," *LC,* Vol. 3, Number 10, pp. 894-896.

6.7.2.4 McCord, B., Hargadon, K., Hall, K., Burmeister, S., "Forensic Analysis of Explosives using Ion Chromatographic Methods," *Analytica Chimica Acta*, 1994, pp. 43-56.

6.7.2.5 Midkiff, Charles, R., "Arson and Explosive Investigation," Saferstein, Richard, Forensic Science Handbook Vol. 1, 2nd ed., Pearson Education Inc.: Upper Saddle River, NJ, 2002, pp. 513-515.

6.7.2.6 Rudolph, T., "The Characterization of Some Low Explosive Residues by Ion Chromatography," FBI Laboratory, Washington, D.C., pp. 213-219.

6.7.3 Questions

The trainee will provide written answers to the following questions:

- What anions are commonly present in water extracts of deflagrated black powder? Pyrodex®?

6.7.4 Practical Exercises

6.7.4.1 The trainee will complete the Ion Chromatography Section of the Trace Evidence training manual.

6.7.4.2 The trainee will analyze water extracts from a variety of known explosive standards and explosive residues. These water extracts will at a minimum include black powder and black powder substitutes.

6.4.7.3 The trainee will analyze the water extracts from Section 6.4.4.1.

6.7.7 Evaluation

6.7.7.1 The trainer will review the written answers to the questions with the trainee.

6.7.7.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

6.7.7.3 Review of practical exercises.

6.8 Fourier Transform Infrared Spectrophotometry (FT-IR)

6.8.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Explain the basic theory of FTIR and be able to explain the function of the major components of the instrument;
- Explain and be able to perform appropriate calibration procedures and/or quality checks as well as routine instrument maintenance; and,
- Prepare samples for analysis choosing the techniques most appropriate to the sample. Interpret the results obtained using library searches or comparison to known standards.

6.8.2 Required Readings

6.8.2.1 Midkiff, Charles, R., "Arson and Explosive Investigation," Saferstein, Richard, Forensic Science Handbook Vol. 1, 2nd ed., Pearson Education Inc.: Upper Saddle River, NJ, 2002, p. 511.

6.8.2.2 Pristera, F., Halik, M., Castelli, A., Fredericks, W. "Analysis of Explosives Using Infrared Spectroscopy," *Analytical Chemistry*, Vol. 32, No. 4, pp. 495-508.

6.8.2.3 Washington, W.D., Midkiff, C.R., "Forensic Applications of Diamond Cell-Infrared Spectroscopy. I: Identification of Blasting Cap Leg Wire Manufacturers," *Journal of Forensic Sciences*, Vol. 21, No. 4, pp. 862-867.

6.8.3 Questions

The trainee will provide written answers to the following questions:

- Describe how a sample of smokeless powder would be prepared for FT-IR analysis.
- Describe how a sample of whole black powder or black powder substitute would be prepared for FT-IR analysis.
- Describe how a water extract of a device would be prepared for FT-IR analysis.
- What is the main band expected in an FT-IR spectrum of whole black powder?

6.8.4 Practical Exercises

6.8.4.1 The trainee will complete the Fourier Transform Infrared Spectrophotometry Section of the Trace Evidence training manual.

6.8.4.2 The trainee will analyze samples from many types of explosives available including black powder and post-combustion black powder, black powder substitutes, smokeless powder, and other explosives commonly encountered.

6.8.4.3 The trainee will analyze dried water and acetone extracts from Section 6.4.4.1

6.8.5 Evaluation

6.8.5.1 The trainer will review the written answers to the questions with the trainee.

6.8.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

6.8.5.3 Review of practical exercises.

6.9 GC-MS

6.9.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Explain the basic theory of GC-MS and be able to explain the function of the major components of the instrument;
- Explain and be able to perform appropriate calibration procedures and/or quality checks;
- Prepare samples for analysis choosing the technique most appropriate to the sample; and
- Interpret the results obtained using library searches and comparison to known standards or published data.

6.9.2 Required Readings

6.9.2.1 Martz, R. M., Lasswell, L.D. III, "Smokeless Powder Identification," *Proceedings of the International Symposium On the Analysis and Detection of Explosives,"* 1983, pp. 245-254.

6.9.2.2 Nowicki, J., Pauling, S., "Identification of Sugars in Explosive Residues by Gas Chromatography-Mass Spectrometry," *Journal of Forensic Sciences*, JFSCA, Vol. 33, No. 5, Sept. 1988, pp. 1254-1261.

6.9.3 Questions

The trainee will provide written answers to the following questions:

- Using electron impact GC-MS, will nitroglycerin be identified in double-base smokeless powders? Why or why not?

6.9.4 Practical Exercises

6.9.4.1 The trainee will complete the Gas Chromatography-Mass Spectrometry Section of the Trace Evidence training manual.

6.9.4.2 The trainee will analyze both single base and double base smokeless powders by GC-MS.

6.9.4.2 The trainee will analyze the acetone extracts of the smokeless powder from Section 6.4.4.1.

6.9.5 Evaluation

6.9.5.1 The trainer will review the written answers to the questions with the trainee.

6.9.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

6.9.5.3 Review of practical exercises.

6.10 Scanning Electron Microscopy-Energy Dispersive X-Ray (SEM-EDS)

6.10.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Explain the basic theory of SEM-EDS and be able to explain the function of the major components of the instrument;
- Discuss the strengths and limitations of the technique including factors which may affect the resulting spectrum, such as escape peaks, sum peaks, etc.;
- Prepare samples for analysis; and,
- Interpret the results obtained.

6.10.2 Required Readings

6.10.2.1 Mosher, P.V., McVicar, M.J., Randall, E.D., Sild, E.H., "Gunshot Residue-Similar Particles Produced by Fireworks," *Can.Soc. Forens. Sci. Journal*, Vol. 31, No. 2, 1998, pp. 157-168.

6.10.2.2 Stromberg, Maehly, Chemical Criminalistics, O. Brandstetter: Wiesbaden, Germany, 1981, pp. 185-200.

6.10.3 Questions

The trainee will provide written answers to the following questions:

- When analyzing black powder via SEM-EDS, what elements would be expected to be identified? Pyrodex?
- When analyzing ammonium nitrate, which elements would be expected to be identified?
- Why would certain elements present in a compound not be identified via SEM-EDS?

6.10.4 Practical Exercise

6.10.4.1 The trainee will analyze common explosive materials and combustion products to include at a minimum black powder, black powder substitutes, flash powder and granulated pool chlorine/sugar.

6.10.4.2 The trainee will analyze the dried water extracts from Section 6.4.4.1.

6.10.5 Evaluation

6.10.5.1 The trainer will review the written answers to the questions with the trainee.

6.10.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

6.10.5.3 Review of practical exercises.

6.11 Thin Layer Chromatography (TLC)

6.11.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Explain how thin layer chromatography may be used in explosives analysis.

6.11.2 Required Readings

6.11.2.1 Parker, R.G., McOwen, J.M., Cherolis, J.A., "Analysis of Explosives and Explosive Residues, Part 2: Thin-Layer Chromatography," *Journal of Forensic Sciences*, Vol. 20, No. 2, pp. 254-256.

6.11.3 Questions

The trainee will provide written answers to the following questions:

- When might it be appropriate to use thin layer chromatography in explosives analysis?
- Why is thin layer chromatography not used routinely in explosives examinations at the Virginia Division of Forensic Science?

6.11.4 Practical Exercises

6.10.5 The trainee will follow as closely as possible the thin layer chromatography procedure outlined in the required reading.

6.11.5 Evaluation

6.10.5.1 The trainer will review the written answers to the questions with the trainee.

6.10.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

6.10.5.3 Review of practical exercises.

6.12 Supervised Casework

The trainee will work at least ten forensic cases as a technician for a qualified explosives examiner. The trainer should ensure as much variety in the casework as is practicable.

6.13 Forensic Significance of Explosives Analysis

The trainer and the trainee will discuss the interpretation of explosives evidence and its relevance and weight in reports and in testimony.

6.14 Report Writing

The trainer will review and discuss with the trainee the standard report wording in Section 2.10 of the Trace Evidence Standard Operating Procedures.

The trainer will provide ten cases previously examined by other qualified explosives examiners for the trainee to review and discuss with the trainer.

The trainee will draft report wording as a part of the analysis of their training sets as well as when performing supervised casework.

Report writing will be evaluated throughout the training period by the trainer.

6.15 Explosives Presentation and Oral Examination

The trainee will prepare a presentation of approximately 20-30 minutes in length which they will present to a group consisting of qualified explosives examiners, the QA Coordinator, as available, and any Director that chooses to attend. The presentation may cover either: the general theory and application of the instrumentation used in explosives analysis; the analytical methodology of explosives and explosive residues; or a current topic that has been approved by the Section Chief that is of interest to the forensic explosives community.

The trainee will field questions regarding their presentation topic as well as questions related to any/all aspects of their explosives training.

6.16 Competency Evaluation and Mock Trial

6.16.1 As the trainee progresses through explosives training, they will begin to process training sets as they would for casework to include drafting a Certificate of Analysis. There will be a minimum of three of these "case" files completed prior to issuance of the final competency test.

6.16.2 Using one or all of the "cases" from 6.16.1, the trainee will undergo a series of "mini-mock trial" practice sessions with qualified examiners from the Trace Evidence Section. It may be useful to include practice sessions with examiners from Sections other than Trace Evidence.

6.16.3 The trainee will be provided with a final competency test for analysis. This test will mimic actual casework to the maximum extent possible and will include at least one whole powder, one "device" for extraction and one sample that does not contain explosives or explosive residues. Additionally, this test will include at least one positive fracture match of tapes for those trainees who have not previously completed documented fracture match training.

The trainee will analyze the final competency test samples and issue a Certificate of Analysis based upon their findings. The trainee will be called upon to defend their results via testimony in a formal mock trial setting. The mock trial will typically be scheduled about two weeks after the explosives presentation and oral examination.

6.16.4 The trainer and the trainee will review the mock trial video tape in a timely fashion.

6.17 Reading List

6.17.1 Anger, V., and Feigl, F., Spot Tests in Inorganic Analysis, ed. 6, Elsevier Publishing Company: Amsterdam, The Netherlands, 1972.

6.17.2 Beveridge, A.D., Development in the Detection and Identification of Explosive Residues, Central Police University Press: Vancouver, BC, Canada, 1992.

6.17.3 Davis, Tenny L., The Chemistry of Powder and Explosives, Angriff Press: Hollywood, CA, 1975.

6.17.4 Ellern, Herbert, Military and Civilian Pyrotechnics, ed. 2, Chemical Publishing Company: New York, New York, 1968.

6.17.5 Feigl, F., Spot Tests in Organic Analysis, ed. 7, Elsevier Publishing Company: Amsterdam, The Netherlands, 1966.

6.17.6 Fordham, S. High Explosives and Propellants, ed. 2, Pergamon Press: Oxford, England, 1980.

6.17.7 Foris, C. M., Hubbard, C.R., and McCarthy, G.J., PDF Workbook: Use of the X-Ray Powder Diffraction File, 4th ed., International Center for Diffraction Data: Swarthmore, PA.

6.17.8 Gabriel, Barbara, SEM: A User's Manual for Material Science, American Society for Metals: Metals Park, Ohio, 1985.

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